ISSN 1110-0419

Annals Of Agric. Sc., Moshtohor,
Vol. 37(3): 2035-2048, (1999).

POPULATIONS OF FUNCTIONAL GROUPS OF SOIL MESOFAUNA IN NON-TUBER VEGETABLE CROPS IN MENOUFIYA

BY

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ABSTRACT

The study investigates activity density of soil mesofauna under (13) thirteen vegetable crops in each of winter and summer seasons. Winter vegetable crops were broad bean, peas, cabbage, lettuce, garlic, onion, and caraway. Summer vegetable crops were soya-bean, cabbage, tomato, egg-plant, okra, and cucurbits.

The total activity density of soil fauna as well as each of herbivores, detritivores and carnivores are affected by many factors. Such of these factors are: crop type, the mosaic pattern of cultivation, host architecture, leaf morphology and the amount of irrigation water.

In winter, broad bean, onion, and caraway recorded the highest values of herbivores abundance 23.2%, 18.1% and 14.8% respectively, of the total population density of mesofauna. Carnivores were highest in cabbage, caraway, onion and lettuce. During summer, herbivores were higher in soya-bean, cucurbits and okra 33.0%, 21.6% and 19.8% respectively, while carnivores recorded 77% in tomato followed by cabbage, egg plant and cucurbits 68.1%, 66.0% and 64.0%, respectively. Ecological balance of the three main functional groups must be considered as indicator for rational use of pesticides applications, especially in such food crops.

INTRODUCTION

In agro-ecosystems, there are many factors affect species composition and community structure of soil fauna populations. Such of these factors are crop pattern (Perfecto and Sediles 1992), crop type (Mikhail and Hussein 1997) and the amount of irrigation water (Hussein and Mikhail 1998).

Community structure of such agro-ecosystem is well represented by the studying of functional (trophic) groups (Ghabbour 1991). He pointed out the importance of studying these functional groups of the soil fauna populations in order to evaluate the balance and structural composition of these groups in such ecosystems. The three main functional groups are herbivores (potential agricultural pests), carnivores (natural enemies of herbivores), and detritivores (essential of soil fertility).

The presence of these three main functional groups illustrate the degree of complexity of food chains occur of such ecosystems as in the case of potato field (Mikhail and Hussein 1997) and other tuber crops (Hussein and Mikhail 1998). This will reflect the degree of balance present in such agro-ecosystems.

The aim of the present study is to investigate activity density, abundance, species composition and community structure of the total soil fauna as well as the three main trophic groups associated with either winter or summer non-tuber vegetable crops in cultivated lands in Menoufiya Governorate.

MATERIAL AND METHODS

The study area and crops

The study comprises the investigation of activity density of total soil mesofauna as well as the main functional (trophic) groups; herbivores, detritivores and carnivores associated with each of winter and summer crop cultivations around the area of Shibin El-Kom town, Menofiya Governorate. The winter crops are broad bean, peas, cabbage, lettuce, garlic, onion and caraway while the summer crops are soya bean, cabbage, tomato, egg-plant, okra and cucurbits. This investigation was carried out during the agricultural season 1995/1996. Normal agricultural practices were followed and illustrated in Tables (1 and 2).

Method of sampling soil mesofauna

The soil mesofauna were collected from the study area by the pitfall trap method as described by Southwood (1978) and Slingsby and Cook (1986). In this method, the number of individuals trapped is primarily dependent on their locomotory activity (Greenslade and Greenslade 1983, Kromp 1990, Mikhail 1993). These are called activity densities rather than population densities (Kromp 1990, Mikhail 1993, Mikhail *et al.*, 1995, Mikhail and Hussein 1997) and can not be related to the abundance per unit area (Kromp 1990) but are taken as number per trap (Mikhail 1993, Mikhail *et al.*, 1995, Mikhail and Hussein 1997, Hussein and Mikhail 1998).

The number of pitfall traps used are varied according to the cultivation period of each crop and shown in Tables (1 and 2).

Statistical analysis

Data of the activity density of the soil fauna were treated by multivariate statistical methods: correspondence analysis CA (Greenacre 1984) and ascending

Table (1) Dates and/or number of agricultural practices applied with winter crops.

	Broad bean	Peas	Cabbage	Lettuce	Garlic	Onion	Caraway
Ploughing	5/11	20/10	29/8	5/11		7/2	7/11
Furrowing		25/10		5/11		7/2	
Sowing	7/11	5/11	-	-	28/10	25/10	25/11
Planting	-	-	4/9	15/11	-	19/2	-
No. of irrigations	5	5	8	6	5	4	6
Chemical fertilization	5/11 & 3/12	6/12 & 9/1	29/8 & 1/10	25/11 & 10/12	6/1	7/2 & 5/11	7/11 & 21/2
Pesticide applications			5 times*			26/4	
No. of hoeing and weeding	2	2	2	1	3	2	2
Harvesting	16/4	29/3	10/1	19/2	7/4	15/6	6/6
Sampling period	21/10 4/4	7/12 28/3	21/10 4/1		7/12 4/4	7/12 25/4	15/2 30/5
No. of pitfall traps used	80	80	40	65	90	95	75

Table (2) Dates and/or number of agricultural practices applied with summer crops.

	Soya-bean	Cabbage	Tomato	Egg-plant	Okra	Cucurbits
Ploughing	2/5		1/4	21/4		21/4
Furrowing	2/5		6/4			
Sowing & Planting	8/5	24/5	6/4	27/4	5/3	2/5
No. of irrigations	10	11	10	7	10	6
Chemical fertilization	2/5	6/6 & 1/8		21/4 & 20/5	25/4	21/4
Pesticide applications			5, 21, 24/5	1/7	10/6	15/6
No. of hoeing and weeding	3	6	2	3	4	2
Harvesting	19/9	15/10				
Sampling period	30/5 6/8	30/5 6/8		9/5 6/8	30/5 6/8	16/5 12/7
No. of pitfall traps used	55	45	40	90	65	40

hierarchic classification AHC (Roux 1985). The computer calculations for CA and AHC were carried out at University of Cairo using DATAVISION programme 1.2 (Roux 1987) developed for APPLE IIe in BASIC.

RESULTS

Results obtained in the present investigation are based on 48 sampled soil fauna species and/or higher taxa with total activity density of 600.00 individuals sampled from all crops and in both winter and summer seasons. The winter season support has 48 species and/or higher taxa with total activity density of 392.77 individual (65%) while summer season support low number, 38, of species and/or higher taxa with total activity density of 207.23 individuals 935%) as shown in Tables (3 and 4).

Figures (1 and 2) show the breakdown of soil mesofauna of the present study into the three main functional (trophic) groups; detritivores, herbivores, and carnivores; as percent of the total activity density of soil fauna. Generally, the three main functional groups are well represented in all crops, in winter and summer seasons. The percentages of detritivores are high in the winter vegetable crops and the percentages of herbivores are high in the summer vegetable crops, whereas the percentages of carnivores are nearly the same in either winter or summer vegetable crops.

In winter vegetable crops, detritivores are high in garlic, broad bean and peas, medium in lettuce and onion low in caraway and cabbage. Herbivores are medium in broad bean, onion and caraway and low in peas, cabbage, lettuce and garlic. Carnivores are high in cabbage, caraway, lettuce and onion and low in broad bean, peas and garlic.

In summer vegetable crops, detritivores are medium in okra and cabbage and low in eggplant cucurbits, tomato and soyabean. Herbivores are medium in soyabean, cucurbits and okra and low in eggplant, tomato and cabbage. Carnivores are high in all summer vegetable crops.

Fig. (3) shows results of the application of CA and AHC techniques to data (Table 3 & 4) of activity density of soil mesofauna sampled from vegetable crops of the present study. Thirty-five percent of the total variance is associated with the first (vertical) axis and 18% with the second (horizontal) axis. The first axis separates winter and summer vegetable crops, based on their soil mesofauna assemblages, with minor exception that winter cabbage is associated with the group that contains summer vegetable crops and okra (a summer vegetable crop) with the group that contains winter vegetable crops. The garlic, a winter vegetable crop, is separated away from the other vegetable crops of the present study. The winter vegetable crops were more or less characterized by the presence of *Aiolopus* spp (Orthoptera, Acrididae), *Gryllotalpa gryllotalpa* (Orthoptera, Gryllotalpidae), *Gryllus domestica* (Orthoptera, Gryllidae), *Labidura riparia* (Dermaptera, Labiduridae), *Geotomus intrusus* (Hemiptera, Cydriidae), *Pentodon bispinosus* (Coleoptera, Scarabaeidae), *Pterostieus* spp. (Coleoptera, Carabidae),

Table (3) Activity density of epigeic soil mesofauna associated with winter vegetable crops (A= broad bean, B= peas, C= cabbage, D= lettuce, E= garlic, F= onion, G= caraway).

Taxa	A	B	C	D	E	F	G
Isopoda	0.31	14.56	2.00	1.23	12.70	0.32	0.60
Collembola	16.81	16.50	0.38	7.77	32.85	11.65	10.00
Orthoptera							
Acriididae							
Chrotogonus homolobamus	0.06	0.56			0.10	0.10	
Aiolopus spp.			1.50			0.75	0.07
Gryllotalpidae							
Gryllotalpa gryllotalpa	0.06	0.38	0.38			0.25	
Gryllidae							
Liogryllus bimaculatus	3.13	2.63				0.45	
Gryllus domestica	0.69	0.44	3.50	0.92	3.60	1.15	1.20
Dermaptera							
Labiduridae							
Labidura riparia	0.81	0.06	3.75	0.08		0.10	0.73
Homoptera							
Aphididae							
Aphis spp.	6.13	1.94		1.08	1.50	2.05	1.93
Neuroptera							
Chrysopidae							
Chrysoperla carnea (larva)		0.13			0.05	0.20	0.13
Hemiptera							
Reduviidae							
Pirates spp.	.0.06						
Cydnidae							
Geotomus intrusus				0.08		0.05	
Coleoptera							
Scarabaeidae							
Pentodon bispinosus						0.05	
Tropinota squalida	0.88	2.00		0.15	0.80	3.85	2.20
Carabidae		0.06			0.05	0.15	0.20
Pterostieus spp.	1.13	0.38	4.00	2.69	1.90	0.70	1.47
Staphylinidae							
Medon ochracen	1.00	0.38		0.54	0.40	0.90	1.07
Gausopterus spp.	0.13	0.06	0.75	4.31		0.10	0.33
Paederus alfierii	0.18					0.25	0.67
Elateridae							
Drasterius bimaculatus						0.05	0.93
Coccinellidae							

Coccinella spp	0.06	0.19				0.05	0.20
Curculionidae							
Phytonomus spp.	0.06			0.15	0.30	0.05	
Lepidoptera (larvae)	0.13	0.44			0.20	0.25	0.60
Lepidoptera (adult)				0.23		0.10	
Pieridae							
Pieris rapa		0.06			0.20	0.20	0.07
Nymphalidae							
Vanessa cardui				0.08	0.05		0.13
Noctuidae							
Agrotis ipsilon						0.05	
Spodptera exigua		0.06					0.13
Diptera							
Syrphidae							
Syrphus corllae	0.94	0.38		0.15	4.15	4.20	2.27
Eristalis spp.						0.10	0.20
Sarcophagidae							
Sarcophaga spp	0.06	0.19	0.50	0.15	0.05	0.55	0.87
Muscidae	0.06	1.31		0.69	44.45	0.65	1.20
Musca domestica	0.25	0.94	0.25	0.62	0.35	0.35	0.33
Calyphoridae							
Chrysomayia albiaps							0.20
Hymenoptera							
Scoliidae		0.06	0.50				
Sphecidae	0.06	0.38	0.38	0.15	0.20	0.15	0.20
Philianthus spp.	0.06	0.19		0.08		0.60	0.07
Apidae							
Apis mellifera	0.13	1.00		0.62	1.30	1.25	0.13
Eusenidae							
Polistes gallicus		0.06				0.10	
Apoidae	0.06	0.19				0.10	0.13
Formicidae			0.50				0.47
Messor spp.	0.06			0.15		0.10	0.53
Monomorium spp.	2.00	0.50	3.13	0.69	3.35	2.10	0.27
Camponotus spp.	0.94			0.23	0.10		1.30
Spiders	5.25	11.25	12.13	6.92	9.95	15.30	23.27
Millipedes		0.06				0.10	
Acarina							
Bdellidae							
Neomolgus aegyptiacus	2.25	1.56			0.60	1.55	0.47
Anopheles spp.	1.50					0.35	0.07

Table (4) Activity density of epigeic soil mesofauna associated with summer vegetable crops (A= soya-bean, B= cabbage, C= tomato, D= egg-plant, E= okra, F= cucurbits).

Taxa	A	B	C	D	E	F
Isopoda	0.23	2.33	0.88	1.00	11.77	
Collembola	0.55	0.33	0.75	0.83	0.38	2.13
Orthoptera						
Acriididae						
Chrotogonus homolobamus			0.38		0.23	0.13
Aiolopus spp.	0.09	0.22	0.38	1.44	0.31	0.13
Gryllotalpidae						
Gryllotalpa gryllotalpa	0.27		0.25		0.08	
Gryllidae						
Liogryllus bimaculatus			0.38	0.44	0.54	
Gryllus domestica	2.27	0.56	0.38	2.89	2.46	1.13
Dermaptera						
Labiduridae						
Labidura riparia	1.55	1.22	2.13	2.78	1.00	2.13
Homoptera						
Aphididae						
Aphis spp.					6.54	
Neuroptera						
Chrysopidae						
Chrysoperla carnea (larva)					0.08	
Hemiptera						
Reduviidae						
Pirates spp.					0.92	
Cydnidae						
Geotomus intrusus	0.09					
Coleoptera						
Scarabaeidae						
Pentodon bispinosus	0.09					
Carabidae						
Pterostieus spp.	2.18	2.22	2.88	1.83	1.23	0.30
Staphylinidae						
Medon ochracen		0.11	0.13			0.13
Gausopterus spp.	0.09	0.22	0.75		0.54	
Paederus alfierii		0.11		0.06	0.23	0.25
Elateridae						
Drasterius bimaculatus	2.09	0.33	0.75	2.44	0.15	3.25
Coccinellidae						

Coccinella spp			0.28	0.15		
Curculionidae						
Phytonomus spp.		0.13				
Lepidoptera (larvae)		0.11		0.17		0.25
Lepidoptera (adult)	0.09	0.11				
Noctuidae						
Agrotis ipsilon						0.25
Spodptera exigua						0.13
Diptera						
Sarcophagidae						
Sarcophaga spp	0.36	0.11		0.22	0.38	0.63
Muscidae		0.67		0.11	0.15	0.25
Musca domestica	1.64	0.44	1.00	1.11	1.85	0.50
Hymenoptera						
Scoliidae	0.18	0.11	0.25		1.38	0.13
Sphecidae	0.09	0.11	0.25	0.22		
Philianthus spp.	0.09					0.13
Apidae						
Apis mellifera	0.45	0.33	0.13	0.22		0.25
Eusenidae						
Polistes gallicus			0.13			
Formicidae	10.73	0.56	1.38	0.61	0.15	2.63
Messor spp.	0.09		0.25		0.23	
Monomorium spp.	5.36	0.22	0.50	1.17	2.38	2.50
Camponotus spp.	1.00		0.63	0.11		
Spiders	16.00	7.88	18.13	16.00	10.46	15.50
Anopheles spp.				0.11		0.13

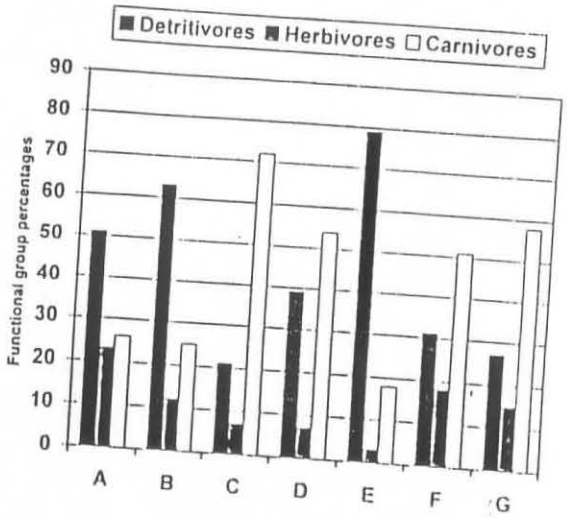

Fig. (1) Percentages of detritivores, herbivores, and carnivores under different winter vegetable crops (A = broad bean, B = peas, C = cabbage, D = lettuce, E = garlic, F = onion, G = caraway).

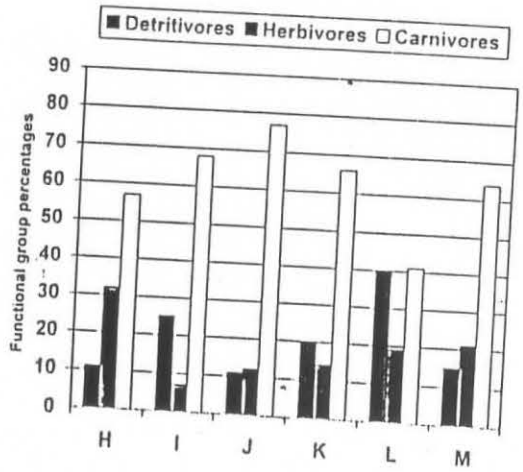

Fig. (2) Percentages of detritivores, herbivores, and carnivores under different summer vegetable crops (H= soya-bean, I= cabbage, J= tomato, K= egg-plant, L= okra, M= cucurbits).

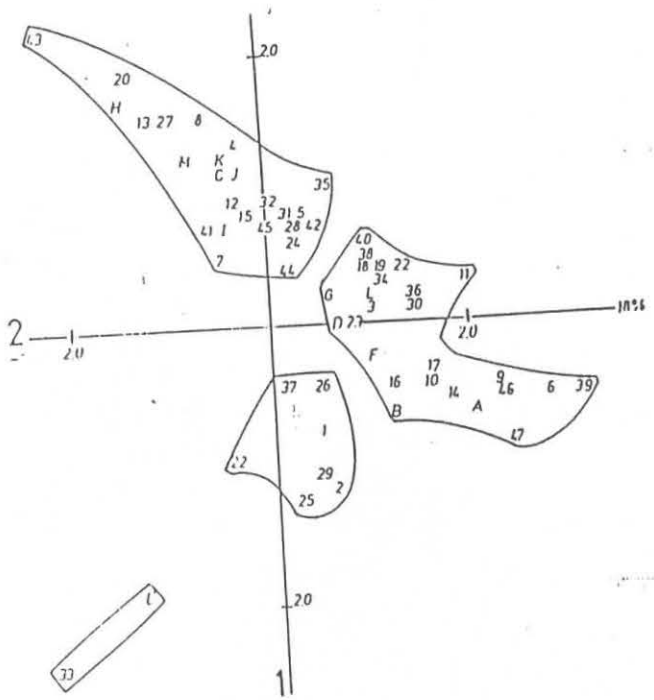

Fig. (3) Graphical representation of the application of CA and AHC methods to data of Tables 3 and 4). Crops: A, broad bean; B, peas; C, winter cabbage; D, lettuce; E, garlic; F, onion; G, caraway; H, soya bean; I, summer cabbage; J, tomato; K, egg plant; L, okra; M, cucurbits. Species: 1, Isopoda; 2, Collembola; 3, *Chrotogomus homolobamus*; 4, *Aiolopus* spp.; 5, *Gryllotalpa gryllotalpa*; 6, *Liogryllus bimaculatus*; 7, *Gryllus domestica*; 8, *Labidura riparia*; 9, *Aphis* spp.; 10, *Chrysoperla carnea* (larva); 11, *Pirates* spp.; 12, *Geotomus intrusus*; 13, *Pentodon bispinosus*; 14, *Tropinota squalida*; 15, *Pterostieus* spp.; 16, Carabidae; 17, *Medon ochracen*; 18, *Gausopterus* spp.; 19, *Paederus alfierii*; 20, *Drasterius bimaculatus*; 21, *Coccinella* spp.; 22, *Phytonomus* spp.; 23, Lepidoptera (larvae); 24, Lepidoptera (adult); 25, *Pieris rapa*; 26, *Vanessa cardui*; 27, *Agrotis ipsilon*; 28, *Spodptera exigua*; 29, *Syrphus corllae*; 30, *Eristalis* spp.; 31, *Sarcophaga* spp.; 32, *Musca domestica*; 33, Muscidae; 34, *Chrysomayia albiaps*; 35, Scoliidae; 36, *Philianthus* spp.; 37, *Apis mellifera*; 38, *Polistes gallicus*; 39, Apoidae; 40, *Messor* spp.; 41, *Monomorium* spp.; 42, *Camponotus* spp.; 43, Formicidae; 44, Sphecidae; 45, Spiders; 46, Millipedes; 47, *Neomolgus aegyptiacus*; 48, *Anopheles*

Drasterius bimaculatus (Coleoptera, Elateridae), Lepidoptera butterflies, *Agrotis ipsilon* and *Spodptera exigua* (Lepidoptera, Noctuidae), *Sarcophaga* spp. (Diptera, Sarcophagidae), *Musca domestica* (Diptera, Muscidae), *Monomorium* spp. and *Camponotus* spp. (Hymenoptera, Formicidae), Formicidae, Sphecidae and Scoliidae (Hymenoptera) and Spiders.

About 21 species and/or higher taxa characterized the summer vegetable crops. These were *Chrotogonus homolobamus* (Orthoptera, Acrididae), *Liogryllus bimaculatus* (Orthoptera, Gryllidae), *Aphis* spp. (Homoptera, Aphididae), *Chrysoperla carnea* (larva) and *Chrysomayia albiaps* (Neuroptera, Chrysopidae), *Pirates* spp. (Hemiptera, Reduviidae), , *Tropinota squalida* (Coleoptera, Scarabaeidae), Carabidae, *Medon ochracen*, *Gausopterus* spp. and *Paederus alfierii* (Coleoptera, Staphilinidae), *Coccinella* spp. (Coleoptera, Coccinellidae), Lepidoptera (larvae), *Eristalis* spp. (Diptera, Syrphidae), *Philianthus* spp. (Hymenoptera, Sphecidae), *Polistes gallicus* (Hymenoptera, Eumenidae), Apoidae (Hymenoptera), *Messor* spp. (Hymenoptera, Formicidae), Millipedes, *Neomolgus aegyptiacus* (Acarina, Bdellidae) *and Anopheles* spp. (Diptera,).

A group of 7 taxa; Isopoda, Collembola, *Phytonomus* spp. (Coleoptera, Curculionidae), *Pieris rapa* (Lepidoptera, Pieridae), *Vanessa cardui* (Lepidoptera, Nymphalidae), *Syrphus corllae* (Diptera, Syrphidae), *and Apis mellifera* (Hymenoptera, Apidae); seem to associate with the group of the summer vegetable crops or the garlic crop. The garlic is characterized by Muscidae (Diptera).

DISCUSSION

In the present investigation, the type of vegetable crops cultivated are winter crops: broad bean, peas, winter cabbage, lettuce, garlic, onion and caraway and summer crops: soya bean, cabbage, tomato, egg-plant, okra and cucurbits. This leads to marked difference in numbers of species and/or higher taxa sampled from either the above mentioned crops or seasons. On the other hand, the intensity of agriculture practices being minimum in the case of onion, caraway, peas and broad bean crops. Generally, these winter crops contain high number of species (more than 30). In other crops, where agricultural practices are maximum, they contain low number of species.

The study of trophic (functional) groups among the populations of soil fauna is important in order to evaluate the structural composition of these groups in different ecosystems (Ghabbour 1991) and illustrate the degree of complexity of food chains occur of such ecosystems (Mikhail and Hussein 1997, Hussein and Mikhail 1998). In the present study, the three main trophic groups; herbivores (potential agricultural pests), detritivores (essential for soil fertility) and carnivores (natural enemies of herbivores); are well represented under all crops, either in winter or summer seasons. These results suggest that there are complex food chains in the investigated crops, this phenomenon was found associated with potato cultivations (Mikhail and Hussein 1997) and tuber crops (Hussein and Mikhail 1998) in the same area of field crops around Shibin El-Kom. Perfecto

and Sediles (1992) found that the abundance of herbivores would be less in the biculture than in the monoculture and the ant foraging activity would be higher in biculture. On the other hand, Hussein and Mikhail (1998) found that herbivores are less abundant when crops form a mosaic pattern of cultivations. In the present study, the winter crops are cultivated in adjacent fields and form a mosaic pattern of cultivation more complicated than with tuber crops (Hussein and Mikhail 1998). In the preset investigation, summer crops cultivated before the harvest of the winter crops. This will increase the degree of complexity of the mosaic pattern of cultivation and consequently lead to the reduction of the abundance of herbivores and increase ant foraging activity associated with summer crops than in winter crops.

Host architecture and leaf morphology are among the possible causes which affect patterns of herbivore densities and abundance (Aguilar and Boecklen 1992). Results of the present study are comparable to those obtained by Hussein and Mikhail (1998). Host architecture and leaf morphology of either winter or summer crops are greatly differ from each other. This will lead to low the abundance of herbivores associated with these crops. These factors as well as the infrequent application of pesticide affect the densities and abundance of herbivores.

The detritivores are more abundant in the case of winter crops. This group is less abundant in summer crops, since surplus amount of water used and subsequent increase in soil humidity as well as the higher availability of organic matter. The abundance of carnivores are slightly high when compared with the other two groups. The abundance of each of detritivores and carnivores in the present study are comparable to results obtained in the case of tuber crops (Hussein and Mikhail 1998) in the same area. Thus the density and abundance of carnivores seem to be oppositely affected by the same factors which affect density and abundance of herbivores.

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تعداد المجموعات الوظيفية لحيوانات التربة ــ متوسطة الحجم ــ بمحاصيل الخضر غير الدرنية فى محافظة المنوفية

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أجريت هذه الدراسة فى زراعات الخضر الشتوية والصيفية بمحافظة المنوفية خلال الموسم الزراعى ١٩٩٥/١٩٩٦، لدراسة كثافة وتعداد حيوانات التربة متوسطة الحجم وأثر هذه المحاصيل على التوازن البيولوجى للمجموعات الوظيفية الثلاث: العاشبات الدقيقة الحجم Herbivores (الآفات المحتملة) والمفترسات Carnivores (الأعداء الطبيعية للعاشبات الدقيقة الحجم) وأكلات النثار Detritivores (المسئولة عن زيادة خصوبة التربة). حللت النتائج إحصائيا بطرق التحليل الإحصائى المتعدد المتغيرات: التحليل التوافقى والتقسيم الهيراركى.

أظهرت النتائج أنه فى محاصيل الخضر الشتوية تميز الفول البلدى متبوعا بالبصل بالكراوية بتواجد نسبة أكبر من العاشبات ٢٣,٢%، ١٨,١% و ١٤,٨% على الترتيب، كما كانت المفترسات ممثلة جيدا فى الكرنب الشتوى متبوعا بالكراوية والبصل ثم الخس.

أما خلال الصيف فقد كان أعلى تواجد للعاشبات بمقدار ٣٣% من الكثافة العشائرية لكل الـ Fauna بمحصول فول الصويا متبوعا بالقرعيات ٢١,٦% ثم البامية ١٩,٨% أما المفترسات فقد كانت ممثلة فى زراعات الطماطم بمقدار ٧٧% ثم الكرنب والباذنجان والقرعيات ٦٨,١%، ٦٦% و ٦٤% على الترتيب.

أما اكلات النثار (امترممات) فقد مثلت ٧٩,٨% من إجمالى الكثافة العشائرية للفونا خلال موسم الشتاء لزراعات الثوم، ٤٠% لزراعات البامية لموسم الصيف وإرتبط ذلك بزيادة الرطوبة والمادة العضوية بالتربة تحت الدراسة.

كما أظهرت الدراسة أن كل من نوع المحصول والموسم الزراعى ونمط الزراعة من العوامل الهامة والمؤثرة على كثافة نشاط وتوزيع كل من العاشبات والمفترسات وكذلك على التوازن البيولوجى بينها الأمر الذى يجب أن يؤخذ كمؤشر لترشيد إستخدام المبيدات ــ لاسيما فى محاصيل الخضر الغذائية ــ أثناء عمليات المكافحة طالما تتواجد الـ Carnivores بنسبة فعالة.